Monitoring the Evolution and Benefits of Responsible Research and Innovation (MoRRI)

RTD-B6-PP-00964-2013

Short draft final report on insights from monitoring the evolution and benefits of RRI in Europe (D11)

Monitoring the Evolution and Benefits of Responsible Research and Innovation
March 2018

Research and Innovation

Monitoring the Evolution and Benefits of Responsible Research and Innovation (MoRRI) -

Short draft final report on insights from monitoring the evolution and benefits of RRI in Europe (D11)

European Commission
Directorate-General for Research and Innovation
Directorate B — Open innovation and open science
Unit B7 — Science with and for society – Mainstreaming Responsible Research and Innovation in Horizon 2020 and the European Research Area

Contact Linden Farrer
E-mail linden.farrer*@ec.europa.eu*

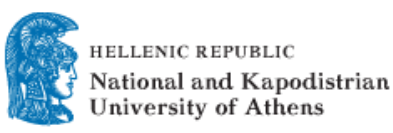
European Commission
B-1049 Brussels

Manuscript completed in March 2018.

EUROPEAN COMMISSION

Monitoring the Evolution and Benefits of Responsible Research and Innovation (MoRRI)

Short draft final report on insights from monitoring the evolution and benefits of RRI in Europe (D11)



2018

Directorate-General for Research and Innovation
Open innovation and open science

Table of Contents

1 Introduction

Studies have shown that there are significant obstacles at both national and organisational levels to mainstreaming Responsible Research and Innovation (RRI) across the European Research Area (Smallman et al., 2015; Mejlgaard & Griessler, 2016). These relate to priorities and incentive schemes, but also simply to the lack of adequate measures of and for responsibility in research and innovation. Inability to evaluate, compare, and benchmark constitutes a barrier to international and organisational learning, whereas identification of useful indicators and metrics for RRI might contribute to bringing RRI from a peripheral position closer to the centre of activity.

The 'Monitoring the Evolution and Benefits of Responsible Research and Innovation' (MoRRI) project contributes to this agenda. It is concerned with the development of conceptually and empirically sound RRI indicators, and it takes first steps towards identifying the impacts of responsible practices in research and innovation. It combines review activities with an extensive empirical programme to formulate and populate measures of RRI. Components of the empirical programme include large-scale survey-based data collection among European researchers, research funding organisations, research performing organisations, societal stakeholder organisations, and manufacturing businesses; an extensive set of case-studies addressing the benefits of RRI; collection and analyses of databases, including bibliometric and patent data; secondary analyses of existing datasets at individual- and country-level; and desk research and qualitative data collection. All relevant deliverables can be found listed in Annex 2.

1.1 From 'science and society' to 'responsible research and innovation'

The changes in how European science relates to society are mapped in the terminology of European Framework Programmes.

Scientists and policymakers have come to appreciate that it is neither possible nor desirable to keep science behind closed doors. The Sixth Framework Programme funded work on 'Science *and* society'. The Seventh Framework Programme urged closer integration, with 'Science *in* Society' as a priority. Horizon 2020 pushed for 'Science *with and for* Society', inviting members of the public into the processes of science as well as into discussions about its purposes.

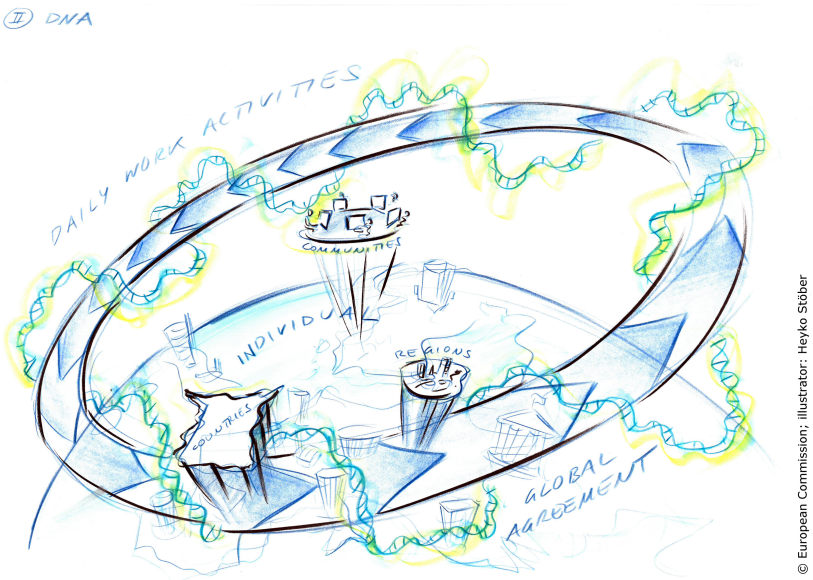
The idea of 'Responsible Research and Innovation' (RRI) in the service of such global challenges is starting to spread through the European research and innovation system.[1] The impact of this idea is hard to measure in the abstract. Under the umbrella of RRI, the European Commission prioritises its 'Science with and for society' six 'key areas' Gender Equality (GE), Science Literacy and Science Education (SLSE), Public Engagement (PE), Open Access (OA), and Ethics (ET) and Governance (GOV).

Responsible Research and Innovation means changing cultures and practices of science, business and policy. The evidence suggests both that change is possible and that it is already happening but at the same time, established patterns of 'how things are done' in research, institutionalised processes and established patterns are often very difficult to overcome and resist structural changes.

[1] Data in MoRRI indicator report, 2017 (D4.3)

1.2 RRI in action

The stated aim of the European Commission's work on 'Science with and for society' is "*to build effective cooperation between science and society, to recruit new talent for science and to pair scientific excellence with social awareness and responsibility*". In recent years, there has been a growing focus, among both policymakers and researchers, on ideas of Responsible Research and Innovation, as a way to ensure that mistakes of technologies past are not repeated and new sources of public value are captured.



© European Commission; illustrator: Heyko Stöber

The question therefore becomes how research and innovation can become more responsive to these while taking into account and mitigating the unanticipated, unintended and undesirable consequences of emerging science and innovation.

RRI is a cross-cutting issue of Horizon 2020, working across the priorities of the programme. The European Commission brings together different issues under the RRI umbrella. Each of these brings its own policy specifics, but they can rightly be grouped together as a common agenda to do with shaping the processes, purposes and products of research and innovation towards social needs and aspirations.

1.3 Visions of RRI

RRI will inevitably mean different things to different people, and demand different forms of engagement in different countries, cultures and scientific disciplines. As with any agenda that proposes changes to cultures and practices, RRI activities will encounter resistance. RRI, if it is to succeed, should be seen as a set of activities that are done *with* and *by* the research and innovation community rather than *to* it. With this in mind, our project's visioning workshop looked for desirable futures that could be a basis for ongoing dialogue between research and innovation communities, stakeholders and the generic public. These visions were articulated with respect to RRI in general, as well as its constituent policy agendas.[2]

The following visions and perspectives on RRI emerged:

- RRI is in your "DNA", embedded in daily activity across all actors.
- There is a multiple and diverse understanding of excellence in research and innovation.
- There is a merit and incentive structure to support RRI at all levels.
- RRI is a creative activity or opportunity rather than a burden.
- In all steps of the research process – agenda setting, evaluation, implementation – society is actively involved.

[2] For more details, see D5.1 (http://www.technopolis-group.com/report/update-literature-review-visioning-exercise-d5-1/).

The vision, jointly developed by the participants, provided both initial substantive and normative orientation for the project's ensuing research process of developing an improved understanding of the benefits of RRI and possible indicators for their measurement.

1.4 About this report

This is a shortened version of the final report of the MoRRI - Monitoring the evolution and benefits of Responsible Research and Innovation – study contract.[3]

This shortened version of the draft final report should be seen as complementary to the report 'The evolution of Responsible Research and Innovation in Europe: The MoRRI indicators report' (2018), which brings together results for the individual indicators as well as methodological comments and observations.

In this shortened report, we aim to highlight some conceptual and empirical findings. Following the introduction (section 2.1), we focus on the empirical results which were tested and two main findings emerged: 11 sub-areas for the RRI dimensions and dedicated country clusters. These are presented in (section 2.3). Section 3 then focuses on the benefits of RRI. Following the definition (section 3.1) and identification (section 3.2) of benefits, we highlight some case studies (section 3.3) and results of a dedicated researchers' survey (section 0). A reflection of impact pathways (section 3.4) and alternative benefits indicators (section 3.5) are followed by a critical reflection and looking at future developments (section 3.6). The final section 4 provides some learning and based on those, suggests ways forward.

2 Emerging patterns of RRI

2.1 Introduction

While issues of responsibility in research and innovation will always be situated in particular social, geographical, and policy contexts, it can be useful to think about broad themes that may help delimit the field of interest.

Each of the six 'key areas' of RRI reflect lines of thinking in policy, practice, and scholarship about the interrelatedness of science and society. The older siblings of RRI include variants of technology assessment, risk assessments, foresight, anticipatory governance, value-sensitive design, research ethics, upstream engagement, and scientific citizenship. One of the strengths of the 'six keys' approach to RRI is its ability to integrate and build on decades of efforts related to understanding and improving the interaction of science and society.

Any attempt to measure and monitor RRI, even if confined to the operational 'six keys' definition, is challenging, not least due to the complexity and subtleness ingrained in each of these areas. Just like in music, a 'key' is indeed an umbrella for multiple scales and chords that go together well. Gender equality, e.g., is more than equal representation of men and women in academia; it also concerns structural changes in academic institutions to promote diversity, and giving priority to gender issues in the contents of research. In this sense, conceptual and empirical clarification of the relevant issues under each thematic key is a prerequisite for monitoring.

In the MoRRI project, several steps were taken in the process towards being able to measure and monitor RRI (see Figure 3). Finally, a set of 36 indicators were selected for the purposes of the MoRRI monitoring study.[4].

---

[3] Contract number RTD-B6-PP-00964-2013, Duration 09/2013-03/2018

[4] The process of identifying and selecting indicators of RRI is described in reports D3.1 and D3.2. For access to these, please click to http://www.technopolis-group.com/morri/

2.2 RRI indicators

The MoRRI project has worked from an intervention logic, which in principle encompasses a need for understanding the inputs in terms of responsible practices, the immediate outputs of these as well as the longer-term impacts. It recognises that benefits are being generated both in relation to the immediate processes and later consequences of responsible practices in research and innovation. When it comes to the RRI indicators, these provide only a limited view of such processes and lack the dynamic view of how practices within the key RRI areas have developed over time.

In compliance with the aims of MoRRI, all indicators target the country level, even though most of them are based on data aggregated from the level of institutions or individuals. The project has sought to capture RRI through indicators that are both relevant, robust and can be collected across all EU countries. These efforts have led to the selection and development of indicators that draw on a range of different data sources, including extensive primary data collection within the MoRRI project through surveys to research performing organisations, research funding organisations, and other science actors, database-based collection of bibliometric data, and qualitative data collection. Table 1 below provides an overview of the 36 indicators. Or, to be more precise, we should say '36+ indicators', since several of the indicators actually cover several individual measures[5].

Table 1 36+ RRI indicators

RRI dimension	Indicator code	Indicator title	Year(s)	Source
Gender	GE1	Share of research-performing organisations with gender equality plans	2014-2016	HEI, PRO surveys
	GE2	Share of female researchers by sector	2007, 2014	Eurostat
	- GE2.1	Share of female researchers - all sectors	2007, 2014	Eurostat
	- GE2.2	Share of female researchers - business enterprise sector	2007, 2014	Eurostat
	- GE2.3	Share of female researchers - government sector	2007, 2014	Eurostat
	- GE2.4	Share of female researchers - higher education sector	2007, 2014	Eurostat
	GE3	Share of research-funding organisations promoting gender content in research	2014-2016	RFO survey
	GE4	Dissimilarity index	2009, 2012	SHE Figures, 2012, 2015
	- GE4.1	Dissimilarity index: higher education sector	2009, 2012	SHE Figures 2012, 2015
	- GE4.2	Dissimilarity index: Government sector	2009, 2012	SHE Figures 2012, 2015
	GE5	Share of research-performing organisations with policies to promote gender in research content	2014-2016	HEI, PRO surveys

[5] For an extensive introduction to every indicator, please consult MoRRI report D4.3, which can be accessed by clicking to http://www.technopolis-group.com/morri/ or the Annex of the MoRRI indicators report (2018). While it is envisaged that the indicators developed in MoRRI will pave the ground for sustained data collection, at this current stage indicators serve mainly to provide a detailed snapshot of activities, status and actions to promote RRI during the period of 2014-16. When it comes to some of the indicators based on secondary data, the reference year is further back.

RRI dimension	Indicator code	Indicator title	Year(s)	Source
	GE6	Glass ceiling index	2010, 2013	SHE Figures, 2015
	GE7	Gender wage gap	2010, 2014	Eurostat
	- GE7.1	Gender wage gap - academic professions	2010, 2014	Eurostat
	- GE7.2	Gender wage gap - technicians and associate professionals	2010, 2014	Eurostat
	GE8	Share of female heads of research-performing organisations	2014-2016	HEI, PRO surveys
	GE9	Share of gender-balanced recruitment committees at research-performing organisations	2014-2016	HEI, PRO surveys
	GE10	Share of female inventors and authors	2005-2016	Patstat, Scopus
	- GE10.1	Share of female authors	2005-2016	Scopus
	- GE10.2	Share of female inventors	2005-2016	Patstat
Science literacy and science education	SLSE1	Importance of societal aspects of science in science curricula for 15 to 18-year-old students	2016	Desk research and interviews
	SLSE2	RRI related training at higher education institutions	2014-2016	HEI survey
	SLSE3	Science communication culture	2012	MASIS
	SLSE4	Citizen science activities in research-performing organisations	2015, 2016	ECSA, Scopus
	- SLSE4.1	Organisational memberships in ECSA	2015, 2016	ESCA
	- SLSE4.2	Citizen science publications	2015, 2016	Scopus
Public engagement	PE1	Models of public involvement in science and technology decision-making	2012	MASIS
	PE2	Policy-oriented engagement with science	2010	Eurobarometer
	PE3	Citizen preferences for active participation in science and technology decision-making	2013	Eurobarometer
	PE4	Active information search about controversial technologies	2010	Eurobarometer
	PE5	Public engagement performance mechanisms at the level of research-performing organisations	2014-2016	HEI, PRO surveys
	PE6	Dedicated resources for public engagement		Not available. Results from HEI and PRO surveys (MoRRI, 2017) inconsistent.
	PE7	Embedment of public engagement activities in the funding structure of key public research-funding agencies	2014-2016	RFO survey
	PE8	Public engagement elements as evaluative criteria in research proposal evaluations	2014-2016	RFO survey
	PE9	Research and innovation democratisation index	2016	SiS survey

RRI dimension	Indicator code	Indicator title	Year(s)	Source
	PE10	National infrastructure for involvement of citizens and societal actors in research and innovation	2016	SiS survey
Open access	OA1	Open access literature	2010, 2016	DOAJ list, PMC, the ROAD list, CrossRef, and OpenAIRE
	- OA1.1	Share of Open Access publications	2010, 2016	DOAJ list, PMC, the ROAD list, CrossRef, and OpenAIRE
	- OA1.2	Citation scores for OA publications	2010-2014	DOAJ list, PMC, the ROAD list, CrossRef, and OpenAIRE
	OA2	Data publications and citations		The information lacks credibility. The indicator is omitted
	OA3	Social media outreach/take up of open access literature	2012-2015	WoS and Altmetric.com
	- OA3.1	Ratio of OA and non-OA publications used in Twitter	2012-2015	WoS and Altmetric.com. Limited to publications
	- OA3.2	Ratio of OA and non-OA publications used in Wikipedia	2012-2015	WoS and Altmetric.com. Limited to publications
	OA4	Public perception of open access	2013	Eurobarometer
	OA5	Funder mandates	2011	DG-RTD
	OA6	Research-performing organisations' support structures for researchers as regards incentives and barriers for data sharing	2014-2016	HEI, PRO surveys
Ethics	E1a	Ethics at the level of research-performing organisations	2014-2016	HEI, PRO surveys
	E1b	Ethics at the level of research-performing organisations (composite indicator)	2014-2016	HEI, PRO surveys
	E2	National ethics committees index	2012	EPOCH
	E3a	Research-funding organisations index	2014-2016	RFO survey
	E3b	Research-funding organisations index (composite indicator)	2014-2016	RFO survey
Governance	GOV1	Use of science in policymaking	2012	MASIS
	GOV2	RRI-related governance mechanisms within research-funding and performing organisations	2014-2016	RFO, HEI, PRO surveys
	GOV3	RRI-related governance mechanisms within research-funding and performing organisations – composite index	2014-2016	RFO, HEI, PRO surveys

2.3 Identification of core RRI indicators – a methodological excursus

The identification of indicators in the MoRRI project revolve around the six key areas outlined by the European Commission in its pursuit of an operational definition of RRI.

There is, however, no automatic alignment between the intended conceptual qualities of the selected indicators and the empirical structure of their interrelatedness. It is, in other words, crucial to examine how they actually relate to each other and the latent variables one would expect them to be indicators for. For the examination of the empirical patterns of the indicators, these limitations have been accommodated by imputing data points to replace missing values, and applying factor analyses to subsets of indicators rather than the full set of 36+ indicators.

In Table 2 below, the altogether 11 retained factors – or what could be called **empirically founded dimensions of RRI** – are presented, along with the indicators most highly loaded to the respective factors.

Table 2 RRI dimensions and core indicators

Dimension	Core indicators
GE action	GE1, GE5
GE status	GE2.3, GE10.1
SLSE training	SLSE1, SLSE2
SLSE culture	SLSE3, SLSE4
PE participation	PE1, PE4, PE9
PE in assessment	PE7, PE8
Ethics in RPOs	E1a, E1b
Ethics in RFOs	E3a, E3b
OA status	OA1.1, OA1.2
OA action	OA3, OA4, OA6
Governance	GOV1, GOV2, GOV3

Calculation: Aarhus University

In sum, 11 RRI dimensions materialised empirically, and out of the basket of 36+ indicators, **25 indicators turned out to be particularly strong** indicators for the 11 dimensions.

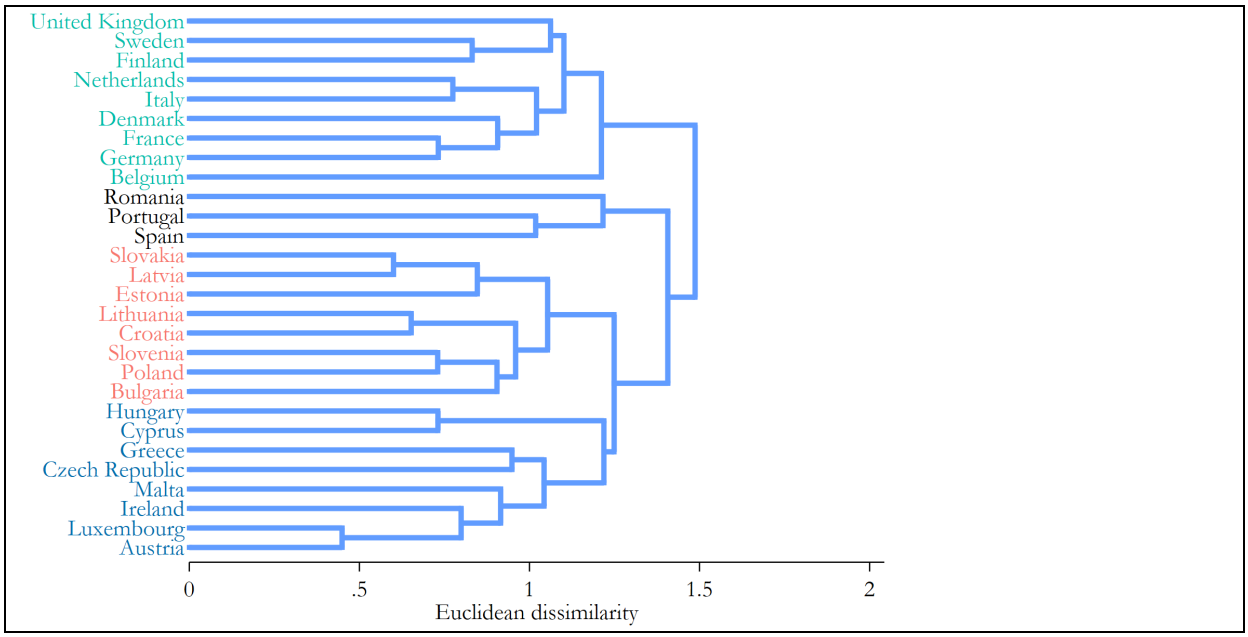
On the basis of those 25 indicators, a 0-1 normalised index was subsequently build for each dimension. In turn, the 11 indexes were used to **characterise individual countries, but also to explore similarities and differences between and within clusters of countries**.

The analysis reveals a **distinct four-class solution**.

- The blue cluster is made of Austria, Luxembourg, Ireland, Malta, the Czech Republic, Greece, Cyprus, and Hungary form a. This means that their individual country profiles are fairly alike, and that they as a group are distinct from the other groups.
- The second cluster in red includes Bulgaria, Poland, Slovenia, Croatia, Lithuania, Estonia, Latvia, and Slovakia.
- The third and smallest cluster in black includes Spain, Portugal, and Romania.
- The fourth and final green cluster includes Belgium, Germany, France, Denmark, Italy, the Netherlands, Finland, Sweden, and the United Kingdom.

A graphical representation of the agglomerative constitution of clusters is provided in Figure 1.

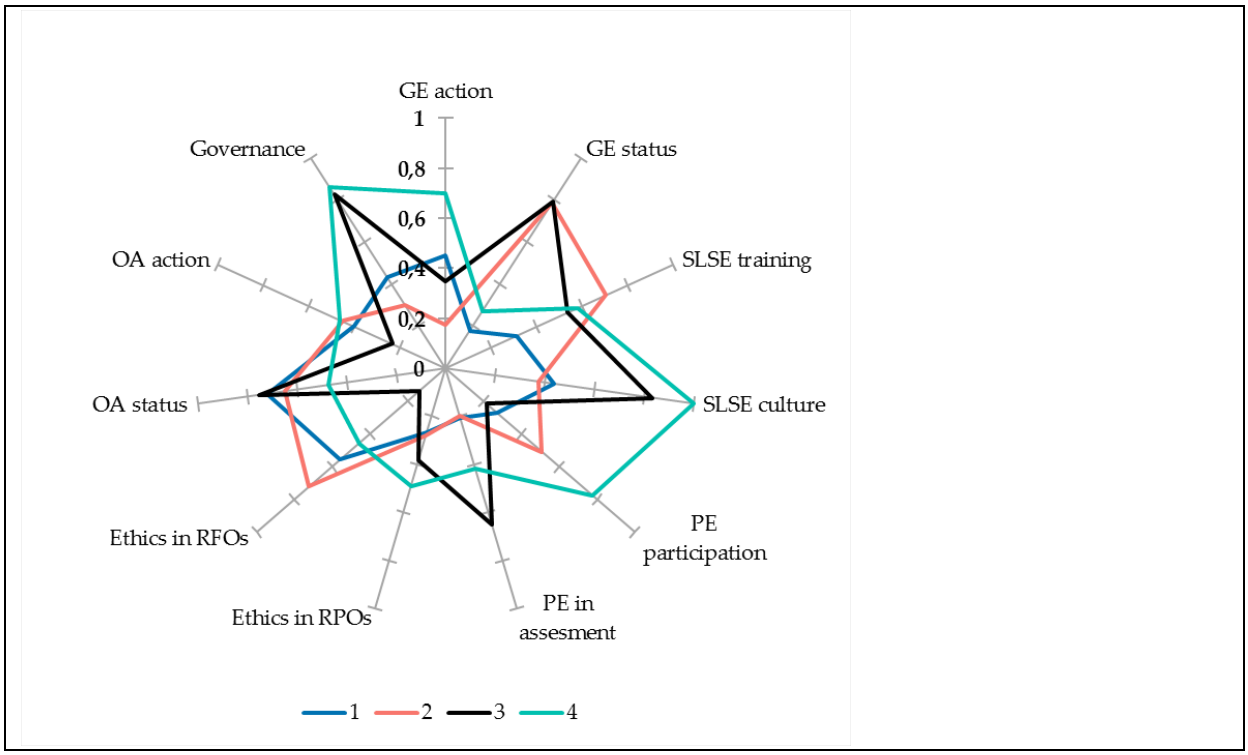
Figure 1 Dendrogram of country clustering



Calculation: Aarhus University

In Figure 2, the characteristics of the four clusters are portrayed. The radar plot shows how well each cluster of countries embraces the 11 RRI dimensions.

Figure 2 RRI characteristics of four country clusters

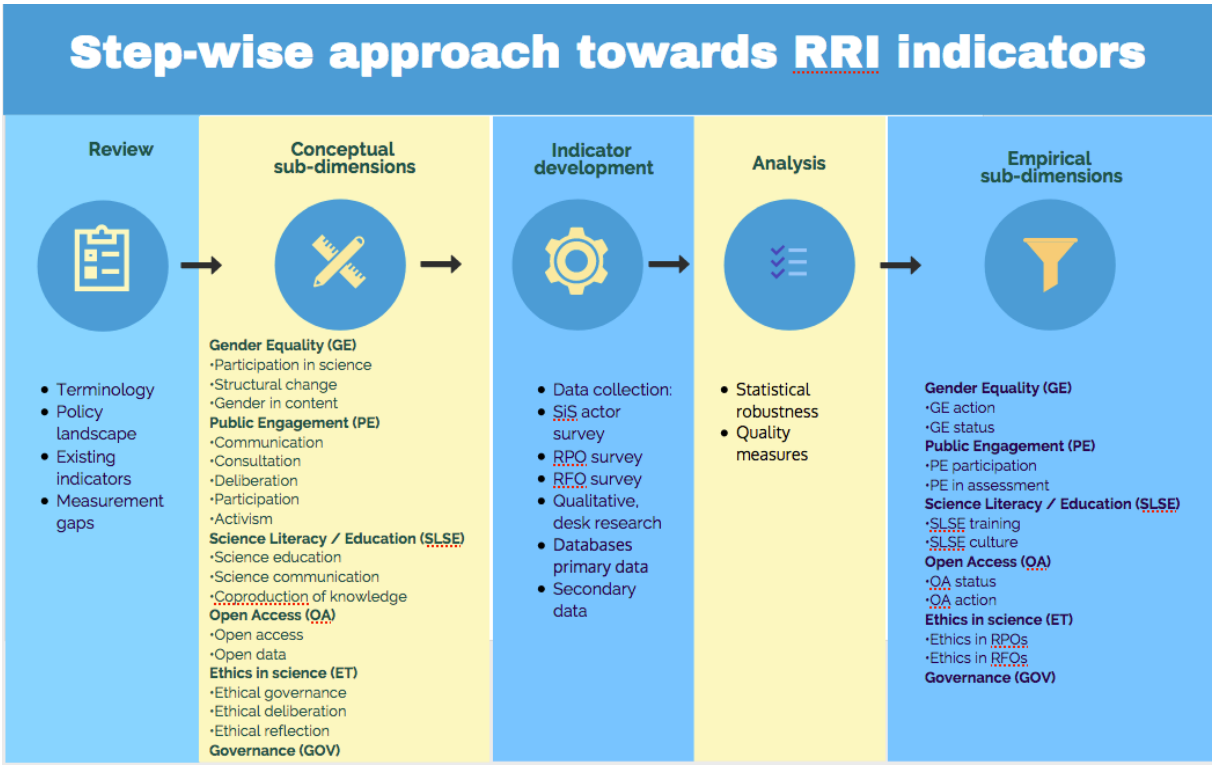


Calculation: Aarhus University

It is important to note that the use of a clustering algorithm to group countries does not mean that countries within a cluster have exactly the same RRI properties. It rather means that the profile of a country within cluster X is more similar to other members of cluster X than to countries belonging to a different cluster. But there can be significant differences in profile, even within the same cluster (see Annex 1 the individual country profiles). The clusters themselves, and the memberships of these, are obviously not stable, but will

depend on future developments at the level of countries, but specifically at the level of organisations within the ecosystems of research and innovation within which responsible practices are cultivated.

Figure 3 Summary of the step-wise methodological approach



3 Impacts and benefits of RRI

While the previous section focussed on the development of indicators of RRI, the following draws from our work on RRI benefits. We explore here what is meant by 'RRI benefits'?, the emergence of RRI benefits by RRI key areas, identification of potential RRI benefits, researchers' perceptions of RRI benefits, impact pathways and the generation of RRI benefits, and monitoring RRI benefits. This is followed by a critical reflection on the work done to date.

3.1 What is meant by 'RRI benefits'?

The indicators developed to monitor the emerging patterns of RRI at Member State level (Section 2) were based on a relatively conventional intervention logic: inputs -> outputs -> outcomes -> impacts. However, the concept of RRI benefits cannot be simply read off this intervention logic as an inevitable extension of the impacts of RRI. Although RRI benefits may indeed be partly or, in some contexts, largely based on an accumulation of positive impacts of RRI, this conceptualisation is not sufficient to capture what is meant by RRI benefits.

There are two important elements that distinguish RRI benefits from being simply an extension of a 'from-inputs-to-impacts' intervention logic:

- RRI benefits can be attributed directly to transformations in processes that are embedded in implementation activities.
- RRI benefits are attributed to transformations with a normative character.

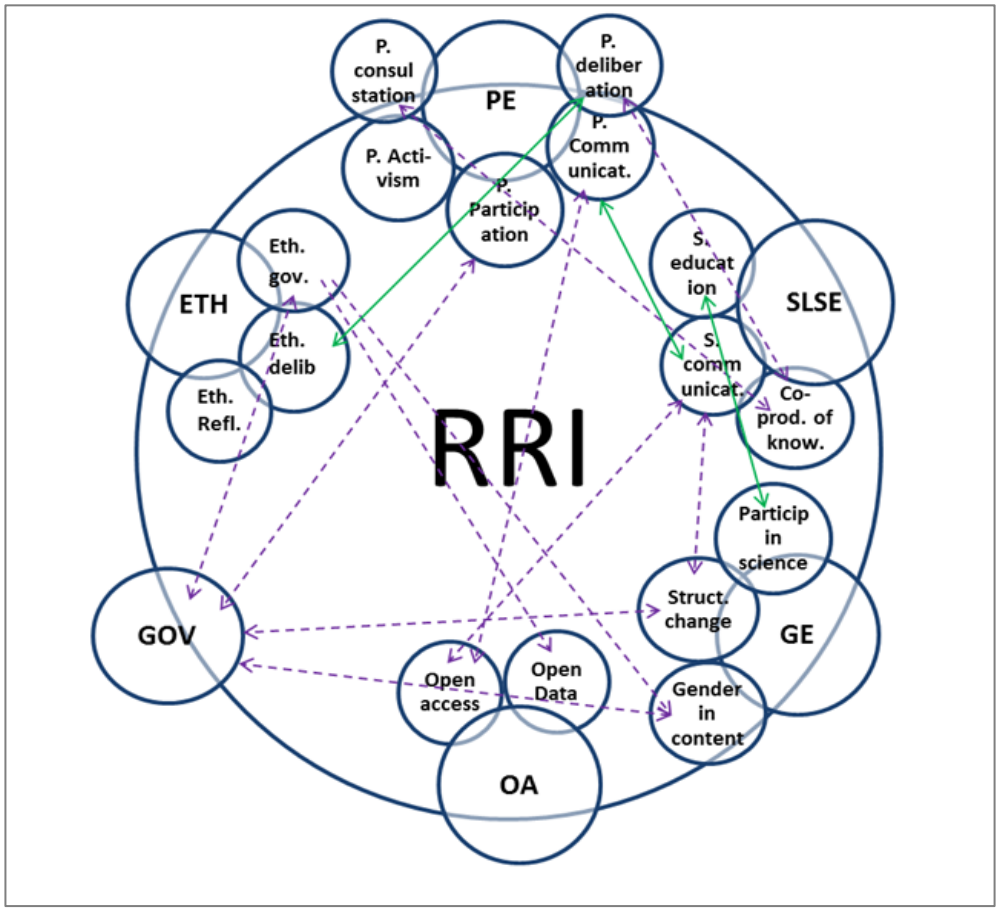
For these reasons, RRI benefits cannot be sensibly interpreted, or systematically monitored, absent of a framework that guides expectations about the (expected) qualities and (desirable) **directions of change**.

3.2 Emergence of RRI benefits by RRI key areas

RRI benefits were initially categorised as **societal**, **democratic**, and **economic** benefits. However, various **scientific** benefits of RRI were also identified (section 3.3).

While the emergence of benefits of these four different types may be attributable to a particular RRI dimension, benefits should also be thought of as driven and/or reinforced by multiple RRI dimensions. For example, the PE and SLSE dimensions are very likely to play mutually reinforcing roles in generating benefits from citizens' participation in S&T decision-making. Indeed, we can generally expect intersections between RRI dimensions and sub-dimensions to be influential in the emergence of RRI benefits, as summarised in Figure 4.

Figure 4 Existing and potential interlinkages between RRI dimensions/sub-dimensions



Source: (European Commission 2015a) MoRRI progress report D3.2

The nature of the benefits emerging from RRI dimensions will be shaped by the way actors are integrated and RRI activities are implemented. From a RRI benefits perspective, Public Engagement can be considered a complex dimension characterised by:

- the opening up of information flows between different actors and sectors of the research and innovation system and between these R&I actors, citizens groups and the general public;
- processes of sharing perspectives and developing mutual understanding of other stakeholders in the research and innovation system and their constituents in wider society; and
- democratisation of decision-making processes regarding research and innovation regulation and policy.

Key mechanisms for the generation of RRI benefits are thus networks of actors integrated at different levels of organising research and innovation and related activities. Institutionalising processes of interaction builds awareness of the interdependence of actors and their interests. Individual actors cease to advocate or act solely based on self-interest, generating benefits for democracy. Such transformations can be expected to lead to economic benefits deriving from improved coordination.

Continuous reflexive attention to the implementation of engagement activities is also required, to ensure these activities do not function simply to enrol actors to the perspective of powerful groups (Stirling 2008). Openness and transparency are important safeguards in this respect.

3.3 Identification of potential RRI benefits

In order to identify and analyse the societal, democratic, economic and other benefits of activities and measures to promote RRI, a variety of case studies was conducted.[6]

In identifying RRI activities and measures for case studies, different levels of implementation were systematically considered. RRI activities were selected that addressed individual actors or certain stakeholder groups (e.g. researchers or PhD students), organisations (e.g. universities or private companies), or broader societal sub-systems (e.g. science in general or research funding). In addition, case study selection considered the expected areas of impacts of the RRI measures under investigation (societal, democratic, and economic).[7]

The case studies combined various methods of data collection and analysis such as desk research and review of documents and interviews with relevant actors, stakeholders or experts.

Box 1 Inclusive methods to empower workers

Bridging the gap between science, stakeholders and policy-makers: Integration of evidence-based knowledge and its application to science and management of fisheries and the marine environment.

The case involved different stakeholder groups - particularly fishermen - in research processes in eleven countries. They became engaged in research planning, data collection, co-production and discussion of research results.

Inclusive methods comprised of mutual mobilisation and learning activities, stakeholder workshops and debates, focus groups, networking events, cognitive maps, joint field observations, participatory sampling, surveys, and other research activities (Raicevich et al 2013).

Involving fishermen in research related to their work **should empower and inform** them. They should profit from the knowledge and insights gained in research. Research results should inform governance and political decision-making about the management of fisheries and empower fishermen in these processes.

In some cases, new policymaking processes were implemented that were **developed together** with the participating fishermen. Through participatory research activities and the inclusion in decision-making processes, fishermen became part of relevant networks and acquired new competences (e.g. data collection methods) that probably strengthened their position in negotiations about fishery management. Furthermore, the **participatory approach** involved fishermen also in evaluation of fishery management. Decision-making took into account their traditional knowledge. The case showed

[6] Ibid.

[7] The notion of scientific impact was not considered at the beginning of this study but emerged during research as important benefit of RRI.

democratic benefits of RRI, but also economic benefits. It had at first (short-term) negative economic effects due to a ban in winter on shrimp fishing that researchers and stakeholders developed together. However, these short-term costs contributed to a positive impact in the end since sustainable fish production was secured.

Democratic, societal and economic benefits of RRI were identified along with an additional group of benefits that has been absent in the literature so far, namely benefits of RRI for science, research and innovation.

RRI activities had a number of **democratic benefits**. PE empowered citizens by involving them into research that was meaningful to them and engaged them in public debates. In some cases this in turn contributed to better decision-making and strengthened the democratic system. SLSE activities helped better-informed decision making as well. Activities that addressed ET and GOV had positive effects on decision-making by providing reliable and trustworthy information. One case study suggested that the potential of RRI activities for informing decision-making could not materialise due to a lack of basic funding for such activities.

As regards **societal benefits** of RRI, PE and GE activities led to research questions and findings that were better aligned with societal needs; GE and SLSE contributed to more equality and social justice. PE activities helped society to participate more fully, and to learn from science. Tennant and colleagues (2016: 11) report as a societal benefit of OA "a general media advantage with OA (…) which can be used as a proxy or pathway to indicated greater societal impact".

RRI was found to have a number of **economic benefits**. In several cases, PE activities leading to more inclusiveness in research helped to create better solutions. PE also increased trust in business; it increased firms' anticipatory capacities and helped them to participate in the shaping of public discourse. Recognising GE and using OA led to better organisation performance. PE helped to collect data more cost effectively. Addressing issues of research ethics and integrity (ET) could help to avoid litigation costs and produce reputational gains. Taking RRI issues into account led to new business and funding opportunities.

RRI had also a number of **scientific benefits**. PE activities and addressing GE in research, framed research questions that took into consideration societal needs and local knowledge. 'This again led to new insights and helped to improve research. PE activities provided researchers with access to new data. RRI also contributed to changes in the science culture. For example, shifting science, curricula and the R&I workforce towards more inclusiveness and diversity, provides opportunities for previously untapped human resources and can increase the numbers of students/researchers from different socio-economic backgrounds. PE helped researchers to acquire new skills and to communicate and work with non-experts in research groups. More diverse research groups performed better than homogenous groups. Activities in SLSE, PE, and ET can increase society's knowledge about and trust in science.

Box 2 Societal benefits due to gendered medical research

Institute of Gender in Medicine at the Medical University Berlin - Charité

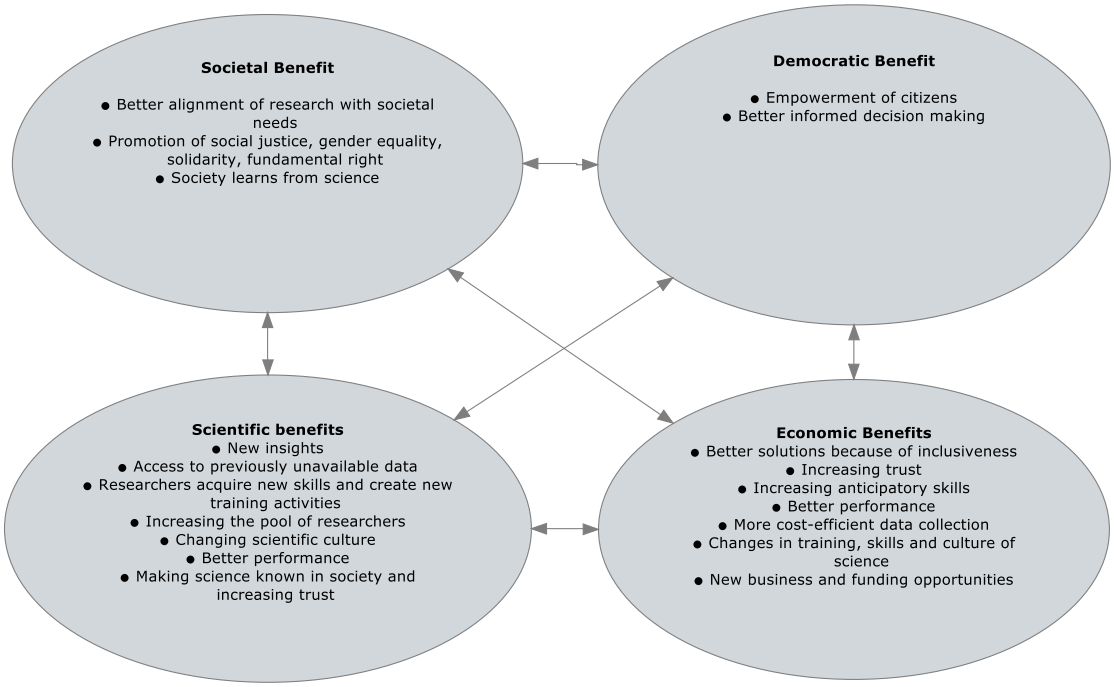
The Institute of Gender in Medicine systematically researches and integrates gender aspects in the research of cardiovascular diseases. By doing so, it contributes to a better understanding of cardiovascular diseases; it improves scientific theories, methods, models and evidence-based therapies. It also contributes to new gender-sensitive curricula in teaching medicine at universities (scientific benefit).

The **societal benefit of gender medicine** is evident, since women – i.e., half of the population – receive more attention of their needs when developing and introducing new pharmaceuticals, diagnostics and therapies. This will increase human health, life expectancy and quality of life. The case also provides an example that limited funding can curtail the potential democratic impact of RRI relevant activities. A

lack of basic, institutional funding however prevents the institute to accept invitations to participate in policy related expert groups and to transfer its expertise to the political arena.

The case study programme also found that the societal, democratic, economic and scientific benefits of RRI are closely interlinked, as illustrated in Figure 5.

Figure 5 Societal, democratic, economic and scientific benefits of RRI



Source: MoRRI 2016, D.5.2

The identification of potential benefits of RRI suggested a rich set of societal, democratic, economic and scientific effects. The case study programme indicates that these different types of benefits of RRI are interlinked, as illustrated in Figure 5 Emerging awareness of the mutually reinforcing relationships between the RRI keys thus appears likely to be an important consideration in the future development of the monitoring system for RRI benefits. Researchers' perceptions of RRI benefits

In order to learn more about perceptions of benefits associated with RRI and its five key areas, two large-scale surveys among European researchers were launched. The first approached researchers who had previously received EU funding. The second addressed researchers with similar structural characteristics (by discipline, gender) but who had not received EU funding (the control group).[8] In order to obtain a picture of researchers' perceptions of RRI benefits, we asked the respondents: (1) whether they have already observed any benefits when conducting an activity in the areas of gender equality, science education, open access, public engagement, or ethics; (2) whether they expect respective benefits in the future or (3) whether they do not expect any benefits.

The analysis of the two groups of researchers, one receiving funding from the EU and the other not, showed that the **framework programme designed by the European Commission makes a difference to the practice of responsible research and innovation**. Not only are EU-funded researchers more familiar with the concept of RRI, they also associate more benefits and supporting factors with it than researchers from the control group do. Furthermore, the EU-funded researchers are more likely to practise activities related to the five main pillars of RRI, i.e. open access, gender equality, science

[8] For more details see Bührer *et al*. 2017; Bührer & Younes 2017).

education, public engagement and ethics. Presumably this is a direct effect of learning through EU-related policies and requirements, as RRI was developed and implemented first by the EU and is not yet – at least not as an acronym – fully known within national research and innovation systems. Furthermore, we can assume that European research and innovation funding typically attracts researchers who engage (stronger) in applied, problem-solving and challenge-oriented research which, as shown by this analysis, is more open towards RRI than pure curiosity-oriented research.

However, the control group's results also show that there is still a long way to go regarding the "universe" of researchers in Europe before RRI is more broadly known and accepted. In this regard, policy intervention should be aware that the most important barrier, from the point of view of the respondents, is a strong overload of tasks. This might be overcome by adopted institutional incentives, more staff in research organisations and reduced reporting duties. Lack of knowledge also acts as a barrier, but this could be overcome by intensified communication of RRI as a concept and particularly the communication of good practice examples. Good practice examples are, for example, illustrations of the advantage of gendered innovations[9] or the good practice examples collected by the EU-funded RRI tools project (Kupper et al. 2015).

The survey results confirm the impression that the institutional environment can positively influence the degree of RRI activities and the general attitudes towards more responsible research and innovation. Researchers working in an institutional environment that systematically supports the practice of RRI, for example, through funding incentives, dedicated staff in charge of RRI pillars etc., are more active in RRI practices than researchers who cannot rely on such structures. Thus, from the point of view of policy makers, active support of institutional changes might help the dissemination of RRI. As we saw from the survey results, the definition of success and/or eligibility criteria for research funding is a further mechanism that encourages a positive attitude towards RRI.

Further factors which influence the practice of RRI and its perceived benefits are the research experience and the scientific discipline of the respondents. Especially for medicine, but in most cases also for the social sciences and the humanities, RRI issues are more important than for the natural and physical sciences.

Another important result is that the longer the period spent working in research, the more the respondents are inclined to conduct a respective RRI activity. We assume that more experienced researchers have more opportunities than the less experienced to invest in such kinds of activities because they are typically already established within the science system, while "younger" researchers still have to focus on their research and the advancement of their academic/professional careers. One might consider changes within the national systems of performance-oriented resource allocation. For example, if public engagement or science education activities were also recognized by the respective key performance indicators (and not only the number of publications and citations etc.), this could support younger, not yet fully established researchers, to address RRI issues without endangering their scientific careers.

A gender effect can be observed primarily within the gender equality pillar. Women support female colleagues and also consider gender aspects in their research design more frequently than men. The use of gender-sensitive language shows no significant differences between men and women.

Generally, the respondents report numerous benefits which have already been observed, particularly scientific and economic benefits. Even if concrete benefits have not yet been

[9] http://ec.europa.eu/research/swafs/gendered-innovations/index_en.cfm?pg=home

observed, the respondents are still quite optimistic that these benefits will occur in the future. This attitude also applies to the control group.

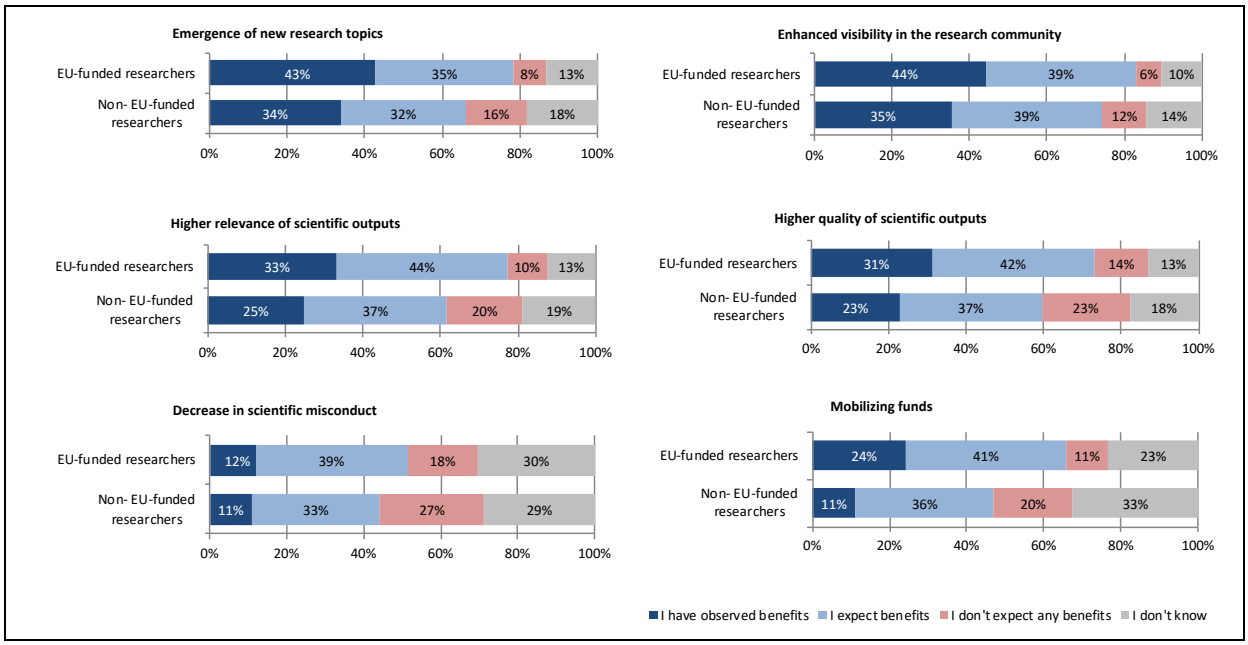
Overall, we ascertain that respondents perceive more supportive factors than hindering barriers. Whereas more than half the respondents mention supportive factors, only slightly more than one-third mention barriers. From the respondents' viewpoint, the most important supportive factors are personal motivation and the institutional strategy, which can play a decisive role.

3.4.1 Researchers' perceptions of benefits of RRI

Figure 6 shows that of the six specific **scientific benefit** items we asked about, enhanced **visibility in the research community** and **emergence of new research topics** were the most important for both survey groups. Approximately one-third of the EU-funded researchers and a quarter of the control group indicate having already observed a positive effect of RRI on both the relevance and quality of their scientific outputs. The effect of RRI activities on reducing scientific misconduct was less strong, while the share of the respondents who don't expect any benefits was highest for this item.

Although the ranking of the scientific benefit categories is almost the same for both groups of surveyed researchers, it is worth mentioning that 'mobilising funds' is much more frequently reported by the EU-funded researchers than by the control group.

Figure 6 Scientific benefits



Source: MoRRI 2017, Researcher's survey

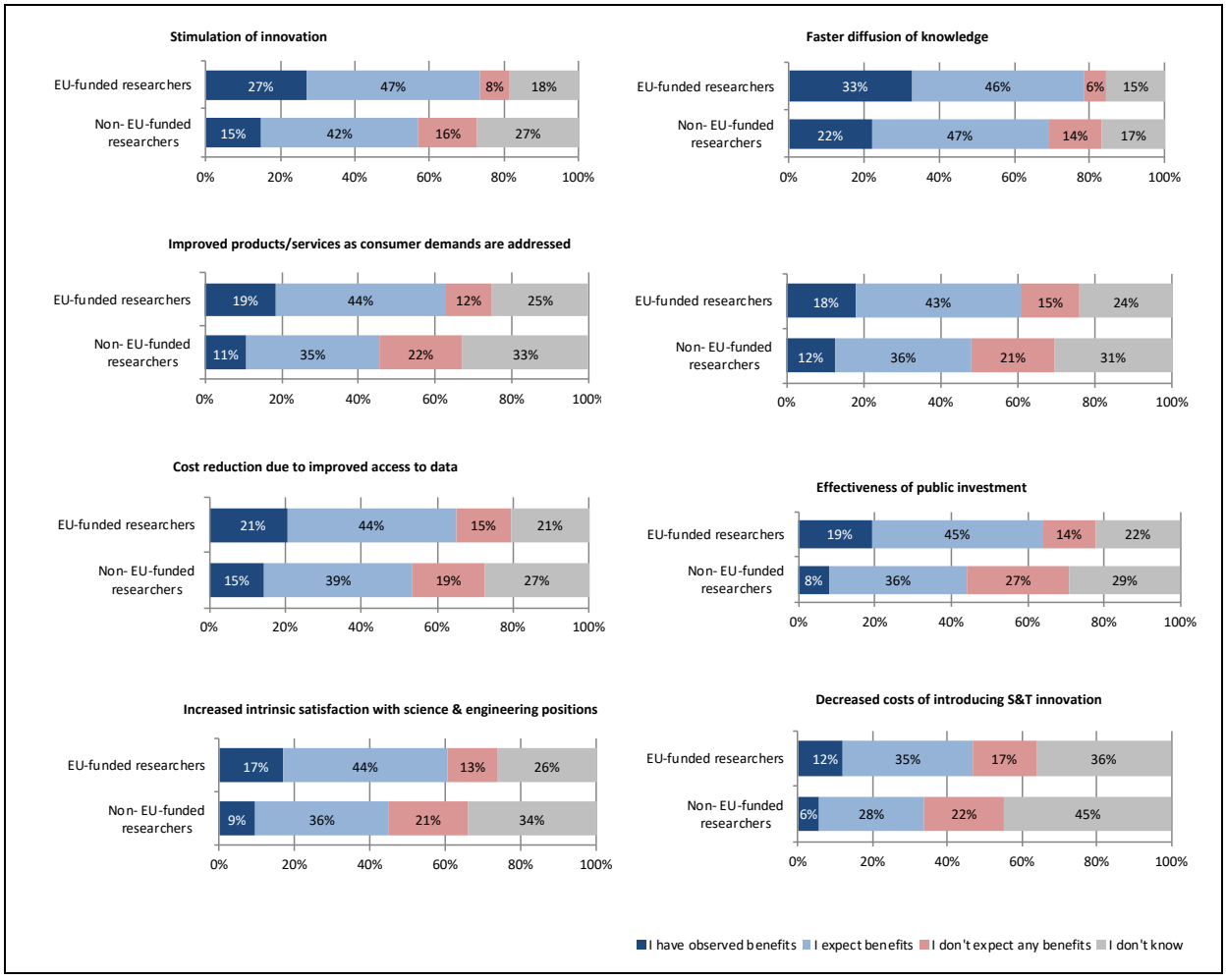
However, the multivariate analysis confirms that the majority of the 'scientific benefit' items differ significantly between the EU-funded researchers and the control group. Five out of six items were perceived differently (all but 'decrease in scientific misconduct'), underlining that – unsurprisingly - EU-funded researchers have had more concrete experiences of, and hold higher expectations about, future benefits.

Responses indicate that researchers do perceive RRI as generating benefits for science, research and innovation. This was particularly the case where researchers had worked on EU-funded projects and were therefore more likely to have encountered RRI concepts.

Turning to **economic benefits** of RRI, Figure 7 shows that of the eight specific economic benefit items we asked about, **faster diffusion of knowledge** is regarded as the most important among the EU-funded researchers, but also more than one-fifth of the control

group respondents reported observing this benefit. Stimulation of innovations is also observed or expected by the majority of respondents in both survey groups, with EU-funded respondents reporting having observed this benefit significantly more often than did the control group.

Figure 7 Economic benefits



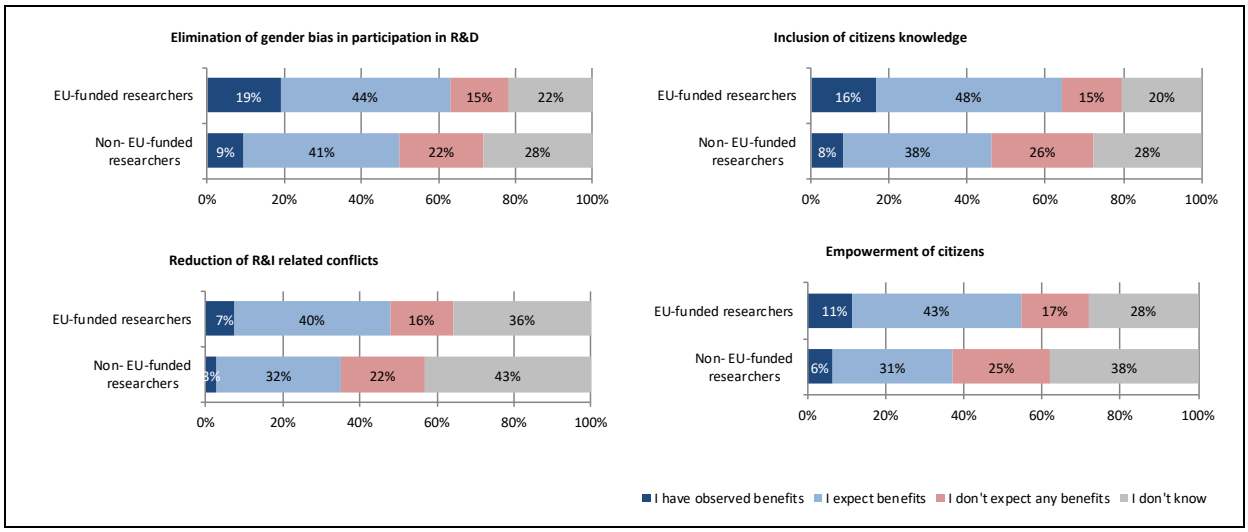
Source: MoRRI 2017, Researcher's survey

For six of the eight economic benefit items, responses differ significantly between the EU-funded researchers and the control group. Only for 'cost reduction due to improved access to data' and 'increase in relevant students and workforce' was there no statistical difference between the responses of the two groups.

Respondents generally observed **democratic benefits** less frequently than they did either scientific or economic benefits. Among the most important democratic benefits are the elimination of gender bias in participation in R&D and the empowerment of citizens. However, even where a benefit had not yet been observed, almost half the respondents expect the respective benefit in the future.

The responses of the two survey groups are significantly different for all four democratic benefit items with EU-funded researchers more inclined to report the respective benefit than researchers in the control group. Looking at scientific disciplines, researchers from the humanities and medicine are more likely to have observed, or to expect, democratic benefits from RRI.

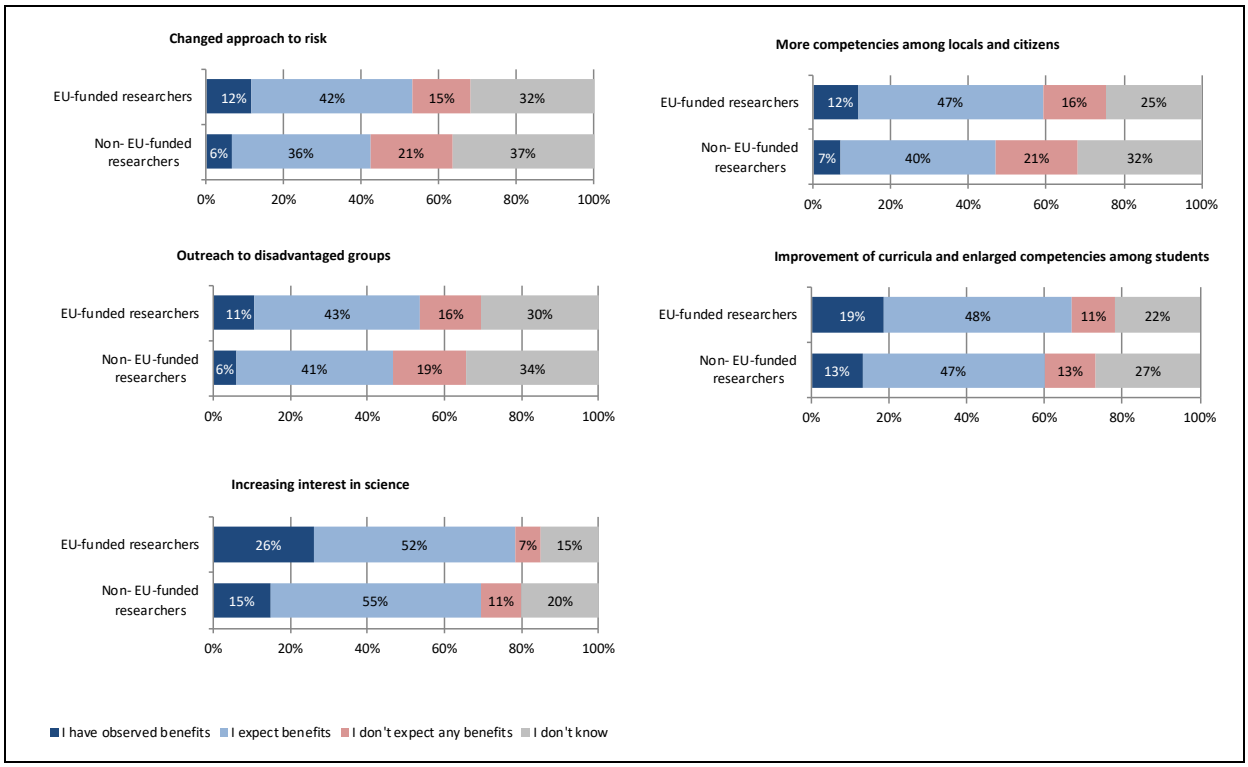
Figure 8 Democratic benefits



Source: MoRRI 2017, Researcher's survey

Of the five **societal benefit** items we asked researchers about, an '**increasing interest in science**' and the '**improvement of curricula and enlarged competences among students**' were the two items that were most frequently reported to have been observed by respondents.

Figure 9 Societal benefits



Source: MoRRI 2017, Researcher's survey

This analysis has focused on comparing perceptions of the benefits of RRI between two groups of researchers, those who have been recipients of EU funding and those who have not.

The MoRRI Research Survey thus provides important information on particular benefits that researchers perceive as arising from RRI. Perceptions of scientific benefits specifically capture observed and expected effects of RRI on the science, research and innovation system. Researchers' perceptions of societal, democratic, and economic benefits capture

observed and expected effects of RRI on the well-being of citizens and the socio-cultural sphere in general.

The development of perception-based metrics and intermediate/foresight indicators, potentially drawing on a large periodic survey of researchers, could conceivably become part of a monitoring system for the evolution and benefits of RRI. Such indicators could track the emergence of expected RRI benefits, for example. However, whilst it is highly advantageous to understand researchers' perceptions of RRI benefits, perhaps the more interesting question is whether, and to what extent, these perceptions line up with those of their fellow citizens.

Of course, whilst perceptions of RRI benefits are important and could potentially provide valuable metrics and indicators for a monitoring system for RRI, these should complement other types of evidence and indicators. More has to be done to attribute observable benefits to the implementation of particular RRI activities or interventions than simply identify and measure perceptions that this is the case. The next section discusses the attribution of societal, democratic, and economic benefits to RRI activities or interventions in more detail.

3.4 Impact pathways and the generation of RRI benefits

Establishing a framework for monitoring the emergence and evolution of RRI benefits implies being able to plausibly identify benefits attributable to RRI and to develop valid and reliable empirical tools for assessing this benefit, preferably at regular intervals. This presents numerous important challenges, including:

- defining particular benefits as precisely as possible;
- attributing benefits to RRI activities or interventions in a meaningful way; and
- designing appropriate and responsible metrics to support assessments of RRI benefits.

It is evident that these challenges are novel and require considerable further research and experimentation to be convincingly developed. This section summarises progress on the second of these challenges.

A standard linear intervention logic is of limited usefulness in seeking to monitor RRI benefits. The RRI indicators proposed in MoRRI do not, as yet, go beyond input, output, and outcome measures. Difficulties associated with developing impact indicators for RRI are those commonly understood in evaluation practice as a) the problem of attribution of effects to specific antecedent events, and b) the compounding effect of the significant time-lag that often exists between the 'causal' events and the emergence of impacts.

Establishing a systematic approach to the linkages between RRI and benefits at the societal scale thus requires a straightforward conceptual framework. The framework proposed posits a set of relations through which the outputs, outcomes, and impacts achieved by RRI measures can be said to promote broader benefits. The concept at the core of the MoRRI model for generating RRI benefits is the impact pathway (or interchangeably, pathway to impact).

Impact pathways for each RRI dimension can be analysed in terms of:

- *integration* – the forms of organising productive interactions among relevant stakeholders;
- *implementation* – the processes embedded in sets of RRI activities which create the conditions for benefits to emerge and/or expand; and
- *contribution* – the inputs of stakeholders to these sets RRI activities.

Impact pathways can be considered to generate systemic change through three modalities[10]:

- *cognitive transformations* refer to changes in thinking and attitudes;
- *procedural transformations* refer to changes in the ways things are done; and
- *competence transformations* refer to systemic changes that effect all relevant actors.

Although these modalities can be separated analytically, they are interwoven in the emergence, institutionalisation, and evolution of impact pathways.

To take one example, impact pathways toward gender equality induce changes that will lead to benefits for the R&I system (and science itself) and for society/the world at large. Within the R&I system, cognitive transformations refer to the proactive and positive attitudes and expectations that researchers and the research community as a whole have toward working in gender mixed teams and to reducing gender bias in R&I. Procedural transformations includes the reform of existing procedures, or the introduction of new procedures, to reduce and eliminate gender bias from all management and other operational contexts, such as project teams and organisational committees. Competence transformations refer to the inculcation of expectations and understandings regarding Gender Equality across the breadth and depth of the R&I system, such that these issues can be worked on collectively from a shared basis. The ultimate objective of these cognitive, procedural, and competence transformations is an R&I system that is free of gender bias.

Impact pathways thus operate to modify attitudes and procedures across the collective of actors involved in R&I. This occurs through productive interaction between actors and the transformative processes embedded in the activities implemented collectively. The following section identifies a number of the critical processes integral to these implementation activities and describes how these are linked to RRI dimensions.

3.5.2 Interactions, transformative processes, and the direction of change

There are numerous contexts, both formal and informal, in which actors come together to define objectives that link science, technology and society. Interactions between these actors are the basis for implementing the activities required to reach these objectives. A number of processes can be identified which promote responsibility in the definition and implementation of shared objectives.

Pluralisation, **inclusion** and **legitimisation** are three particularly important processes that emerge through impact pathways, particularly in terms of the normative alignment of R&I and society, nevertheless, several other processes play also important facilitating roles. **Diffusion** refers to the movement of information through networks of actors, including the sharing of relevant information, good practices and research findings. For example, open access to scientific publications and project reports can stimulate social innovation and place-based problem-solving. **Adaptation** refers to the way R&I institutions progressively conform to the expectations of society, for example through reformed education and training or ethical standards that benefit society. Recognition refers to a generalised understanding that S&T issues always also involve choices that will impact on society in different ways depending on their substantive content, presenting ethical dilemmas of many different shapes and sizes.

[10] The three transformative modalities described here were developed by the MoRRI project team during the project workshop hosted at the IHS in Vienna in May 2016.

3.5 Monitoring RRI benefits

Three observations can be made regarding the MoRRI identification of potential RRI benefits. First, the potential **metrics and indicators** of RRI benefits developed through the case studies and the visioning workshop phases of the project were **not evenly distributed across RRI dimensions**. The PE, GE and, to a lesser extent, SLSE dimensions contain substantial numbers of potential benefits. A relatively small number of benefits were identified for Ethics and OA, whilst none were identified for Governance. Second, **potential RRI benefits are not distributed evenly by type**. Economic benefits were less readily identifiable for the PE and SLSE dimensions. Democratic benefits were lacking in the Ethics and OA dimensions. Third, the character of the benefits identified varies considerably. Many RRI benefits identified were of a very general character, which is logical when considering benefits at a societal scale. The narrower benefits identified were often focused mainly on the R&I system itself. Whilst benefits for science and for the R&I are important in themselves, these will take time to translate into benefits at a societal scale (where applicable).

The problem of attribution of very general effects to RRI processes and outcomes is a significant challenge for developing a monitoring system for RRI benefits. Lengthy time-lags can occur between observed changes in the R&I system, which might be monitored through indicators of RRI outcomes, and flow-on or emergent benefits to society at large. Benefits emerging from RRI interventions may not yet be evident, partially or fully, regardless of the available outcome indicators. The problems of attribution and temporal lag were foreseen in the MoRRI project design, nevertheless assigning causal links between RRI activities and impacts and societal-scale benefits remains problematic. This is measurement theory challenge in the field of indicator development generally.

Awareness of these challenges and the need for further research, experimentation, and technical development does not mean we cannot move forward with monitoring the evolution and benefits of RRI. The initial strategy for developing metrics and indicators of RRI benefits relies on three elements:

- Intermediate indicators based on metrics of RRI outcomes that are taken as proxies for assumed future societal, democratic, or economic benefits;
- Indicators developed according to an impact pathways model that interpret RRI benefits as generated through transformative processes embedded in RRI activities and interventions and as a consequence of the outcomes of these actions; and
- Network indicators focused on the alignment of R&I and society within defined sub-systems.

The rationale for this diversified approach is that whilst constraints in terms of conceptualising RRI benefits and the state-of-the-art of impact measurement continue to evolve, progress can be made in developing a monitoring framework for RRI benefits based on these approaches. The indicators of RRI benefits are products of a first stage of development and should be regarded as a provisional set of data/metric test cases.

A total of eleven indicators of RRI benefits were proposed. The three intermediate indicators are based on indicators of RRI outputs and all are indicators of democratic benefits. In terms of RRI dimensions, one intermediate indicator is for PE and two for GE.

Table 3 Proposed indicators of RRI benefits

Indicator type	Indicator name (tag)	Type of benefit
Intermediate	Citizens' participation in research and innovation (PE-DEM1)	Democratic
	Reduction in bias against women's participation in research and innovation (GE-DEM1)	Democratic
	Proportion of research that includes a gender dimension (GE-DEM2)	Democratic
Modelled on pathways from RRI outputs/ outcomes to benefits	Citizens' perspectives feature in research and innovation policy making (PE-DEM2)	Democratic
	Training of researchers in public communication (PE-SOC1)	Societal
	Citizens' awareness and understanding of science and technology choices and policy decisions (SLSE-DEM1)	Democratic
	Gender relevance of research and innovation outputs (GE-ECON1)	Economic
	Image and attractiveness of research and innovation careers (ETH-SOC1)	Societal
	Access to and utilisation of open data (OA-ECON1)	Economic
Network	Degree of diversity in research and innovation networks (GOV-DEM1)	Democratic
	Degree of coherence in research and innovation networks (GOV-SOC1)	Societal

Source: MoRRI progress report D6. (2016)

3.6 Critical reflection and future developments

This section summarises briefly the limits to the progress made to date in developing metrics and indicators of RRI benefit that are fit for purpose. It then proposes a number of interrelated tasks that could contribute to further extending this progress.

There are four main points that should be kept in mind from a critical perspective.

- The **conceptual basis** for the definition of RRI benefits remains a work in progress. While MoRRI has developed a working definition that has facilitated progress on developing elements for a monitoring system, further work is needed. For example, a clearer distinction between the concepts of impact and benefits, and the relationship between them, is probably required.

- The **metrics and indicators** for RRI benefits developed are provisional and yet to be fully refined. Next steps include: a) critical reflection on the validity of the proposed metrics as indicators of the phenomena described (as has been undertaken for the indicators of RRI); and b) assessment the practicality and cost of proposed original data collections where applicable.

- There has been no scoping work undertaken on the **suitability** of the proposed indicators of RRI benefit for designing data visualisations or user tools that allow for the interrogation of indicators and their display.

- Further work could be done on **potential RRI benefits indicators** based on perceptions, along the lines pioneered by the Expert Group on RRI indicators. Perceptions based metrics could make a valuable contribution to an overall monitoring system for the evolution and benefits of RRI. However, this will need a more clearly specified conceptual rational that links a particular hypothesis to an observable change in perceptions. Perceptions indicators would also require very sound footings for making comparison between citizens of Member States who are embedded in distinctive socio-cultural contexts. For this reason, a purpose-built replicable *Eurobarometer*-type survey

that could adequately control for national science cultures would almost certainly be required.

As described in Section 2, progress in monitoring the evolution and benefits of RRI has led to the development of a set of 36+ indicators of RRI that are comparable at member state level. The 36 indicators of RRI include 14 input indicators, 11 output indicators, 5 outcome indicators, and 6 mixed or tailorable indicators. There are no RRI impact indicators. The **development of impact indicators for RRI will be an important step**, which is currently constrained and will be inevitably shaped by the moving frontier of the state-of-the-art in developing impact indicators generally.

The eleven sub-dimensions were then used as basis to develop four country clusters of RRI performance. As the summary of the country clusters illustrates (see Table 4), the implementation of RRI is differently configured across the four country clusters identified. Logically we might expect that the RRI benefits that emerge and become consolidated in different countries will be shaped by the contours of their RRI implementation profile.

Table 4 Country cluster implementation profiles and available indicators

Cluster colour	Countries	RRI implementation profile	Monitoring system indicators (type)
	Austria, Cyprus, Czech Republic, Greece, Hungary, Ireland, Luxembourg, Malta	• OA status • Ethics in RFOs	• Outputs • Inputs, process mechanisms
	Bulgaria, Croatia, Estonia, Latvia, Lithuania, Poland, Slovenia, Slovakia	• GE status • SLSE training • PE participation • Ethics in RFOs	• Inputs, outputs, outcomes • Inputs • Inputs, outputs • Inputs, process mechanisms
	Portugal, Romania, Spain	• Governance • GE status • SLSE training • SLSE culture • PE in assessment • OA status	• Inputs • Inputs, outputs, outcomes • Inputs • Outputs • Inputs • Outputs
	Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Sweden, UK	• Governance • GE action • SLSE training • SLSE culture • PE participation • Ethics in RPOs	• Inputs • Inputs, outcomes • Inputs • Outputs • Inputs, outputs • Inputs, outputs, context

Source: MoRRI 2018

In terms of the available metrics and indicators that populate the monitoring system currently, there is a reliance on upstream input indicators combined mainly with output indicators. At this stage, outcome indicators are only associated with the (relatively mature) implementation of GE. RRI implementation profiles constructed on the basis of input and output indicators are useful for highlighting where countries in the different clusters are making their strongest investments and efforts in RRI. Absent of indicators of actual impacts, these profiles can nevertheless also usefully inform our expectations about expected impacts.

Periodic assessments of the country clusters will reveal movements of member states between clusters as their implementation of RRI progresses. Transformations in the basis for emerging benefits would logically bring about change in the generation of RRI benefits,

with some time lag. In addition, country clusters may shift around as the monitoring system adds indicators of impact that provide an additional information type.

The country clusters thus provide us with an empirical orientation for the RRI benefits we might expect to see emerging in different countries, along with insights into the types of activities and impact pathways we should seek to monitor.

Future work could also consider more diverse modes of assessment of the benefits of RRI. These should also be sensitive to the existing RRI implementation profiles associated with different countries. For example, these new modes could focus on developing tools for assessing the alignment of R&I with the needs, expectations, and values of citizens and society. For example, more attention could be paid to priority setting in R&I funding to monitor whether the allocation of research grants and support for research and innovation programmes maps well onto observed needs of stakeholders, users and citizens. Designing innovative modes of assessment of the societal value of research would undoubtedly improve our capacity to identify and monitor the emergence and evolution of the benefits of RRI.

4 Conclusions and Outlook

RRI has come to stay. Whether it is encountered under this particular name, whether it is all or part of its six key areas or a similar but different set of dimensions than those suggested by the European Commission and the present report, concerns about the direction and pace of research and innovation are present in all technologically-advanced countries. R&I is not only expected to increase knowledge or productivity but it is called upon to focus on the emerging global challenges and get involved in mitigating risks and dealing with ethical dilemmas directly connected to technological progress. In this spirit R&D governance is reshaping.

Europe has been a pioneer in taking initiatives to address societal challenges plus adopting recommendations, incentives and regulations in an effort to both sensitise and/or force actors to incorporate responsible behaviour in their R&I activities. MoRRI, as a beneficiary of these incentives, has contributed to developing tools to measuring and monitoring RRI. Through the systematic review of theoretical discussions, the visioning workshop, the methodical collection of data plus the conception and systematic testing of selected indicators, MoRRI concluded with new academic insight and relevant policy conclusions for RRI contributing to the debate on the direction and pace of progress of research and innovation and in particular its strengthened efforts to meet global challenges.

In order to materialise widely, "RRI needs to be part of our DNA" – as stated in the visioning workshop within MoRRI. Several benefits of RRI were identified and debated such as policy benefits, benefits for research itself but also societal and industry-related ones.

MoRRI has produced a tool that can help map and compare RRI activities. This tool presents many thought-provoking results but is inevitably in its infancy as it has not been extensively tested. The 36+ and the suggested reduction down to 23 indicators are an important first step towards standardising data collection and allowing for comparisons. Future work should explore the potentials **of developing indicators targeting RRI at organisational levels**.

One aspect that needs to be addressed here too is the question on how often should data be collected? We have seen form the survey data that for some indicators, the year to year changes were marginal. Given the effort needed to collect information and data, it may be advisable to **collect data only every two to three years**.

In order to take advantage of existing collection efforts at EU-level – be it through the SHE Figures, the open science monitor, ERA monitoring and other relevant activities – a **smart inclusive and creative data collection strategy** is needed. A potential source could also be provided with a relevant adaptation of the reporting requirements of FP funded projects.

The merit of MoRRI is the encompassing approach for all six keys and all FP participants. The case has been made to organise the **systematic data collection** of the 23 indicators that were not retrieved from existing data but involved primary data collection using either surveys, databases, or qualitative approaches

One of the main outcomes of MoRRI was the use of the 11 RRI dimensions to characterise and cluster the EU member states. This clustering of countries based on their RRI indicators can be a valuable source for policy intervention at the Commission level; it **helps to identify areas for intervention** in the context of the European Semester for individual countries. It can also nurture new ideas for future Calls for Proposals. At the same time, at member state level it gives ideas on interregional cooperation and individual areas for improvement.

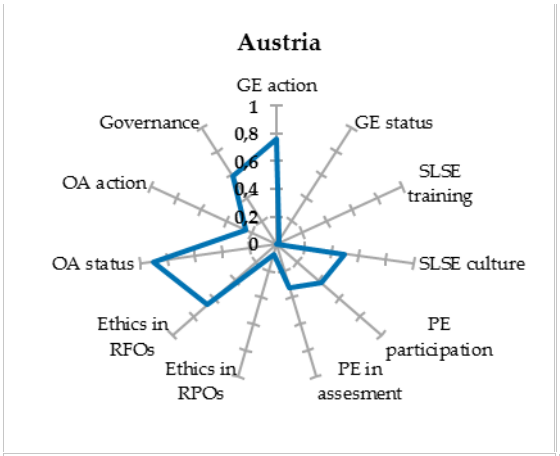
Case studies were conducted in the context of MoRRI to investigate, precisely through narrative and not only indicators, the potential benefits of RRI. **Democratic and societal benefits, as well as scientific benefits were more visible** and easier to capture than economic benefits. This again does not imply less benefits but the need for more systematic research. The case studies suggest that economic benefits are more difficult to capture due to time lags and attribution problems. It may also be argued that different kinds of benefits are better linked to specific keys, i.e. science education, science communication and the co-production of knowledge are more likely to lead to democratic and scientific benefits whereas open access is more likely to lead to economic and democratic benefits in the long run.

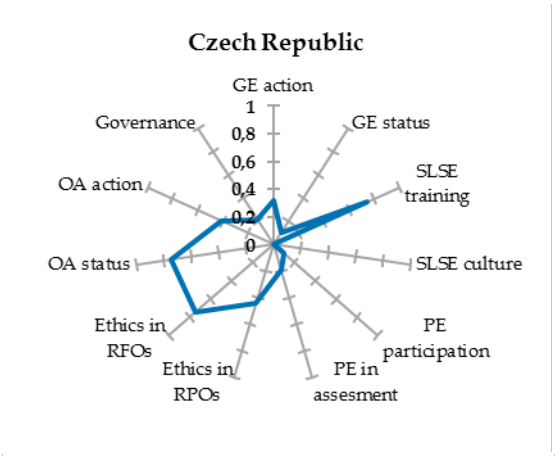
Regardless of both the conceptual and practical challenges of measuring and monitoring RRI, all in all, the data collected and analysed during the course of the MoRRI project demonstrate that RRI has taken root across Europe. Of course, we observe marked differences between Member States with regard to their individual paths towards institutionalising RRI, reflecting different contexts and socio-economic conditions. And even those countries currently at the forefront of aligning policies and practices with the ambitions of RRI, will need to step up their efforts if they actually want to fulfil the vision of a genuinely renewed relationship between science and society. However, this is not a message of despair, on the contrary. As RRI is being concretised for and embedded in different contexts, the approach needs to be adjusted to specific circumstances, thereby legitimately creating variety, not uniformity. At the same time, MoRRI gathered evidence that the European Framework Programmes and related efforts to mainstream RRI make a significant difference when it comes to the awareness, expectations and perceptions of the approach. These findings are an encouragement to continue further embedding RRI in research and innovation funding, while enabling experimentation and bottom-up mobilisation.

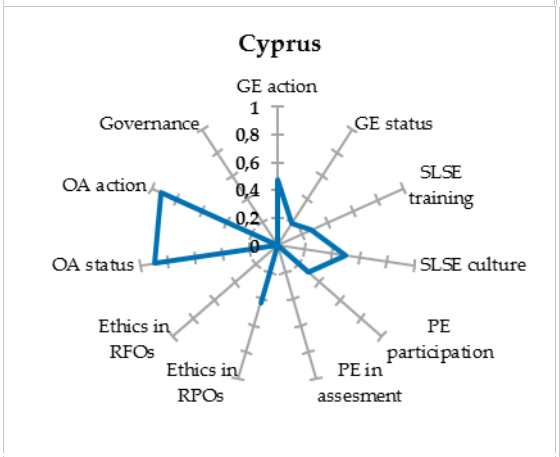
In a nutshell, MoRRI has advanced the notion, the measurement and the research on RRI benefits. It paves the way towards better understanding, shaping and addressing RRI, as it offers tools for monitoring, ideas for further research and in some cases a good background for policy experimentation. But there is still a long way to go. RRI is not a crystallised notion and as such it needs more research, investigating and testing.

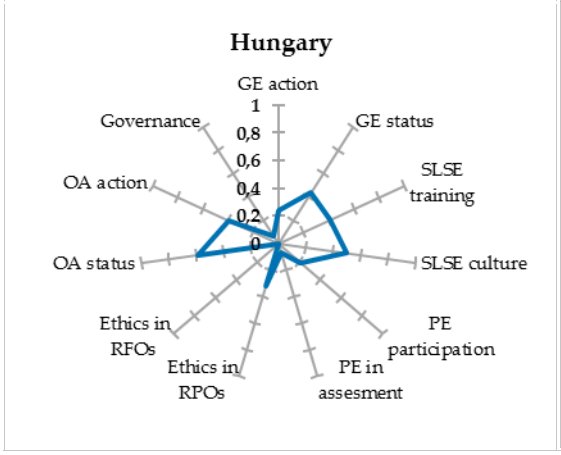
ANNEX 1- RRI COUNTRY PROFILES BY CLUSTER

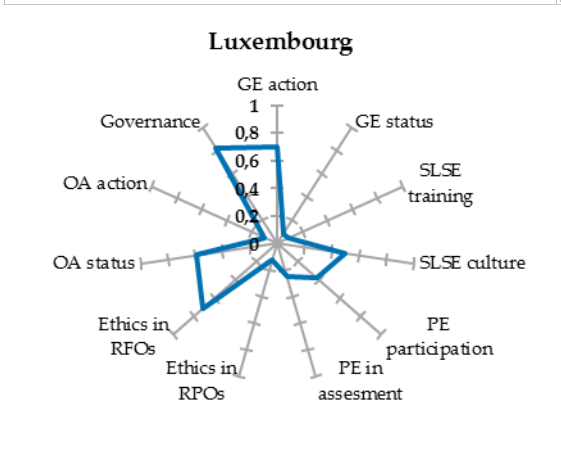
Cluster 1 (blue)

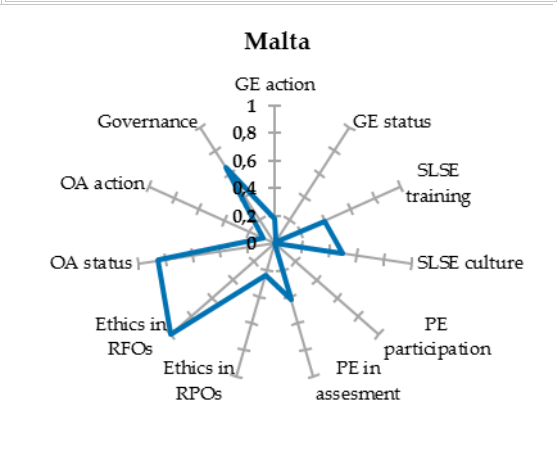




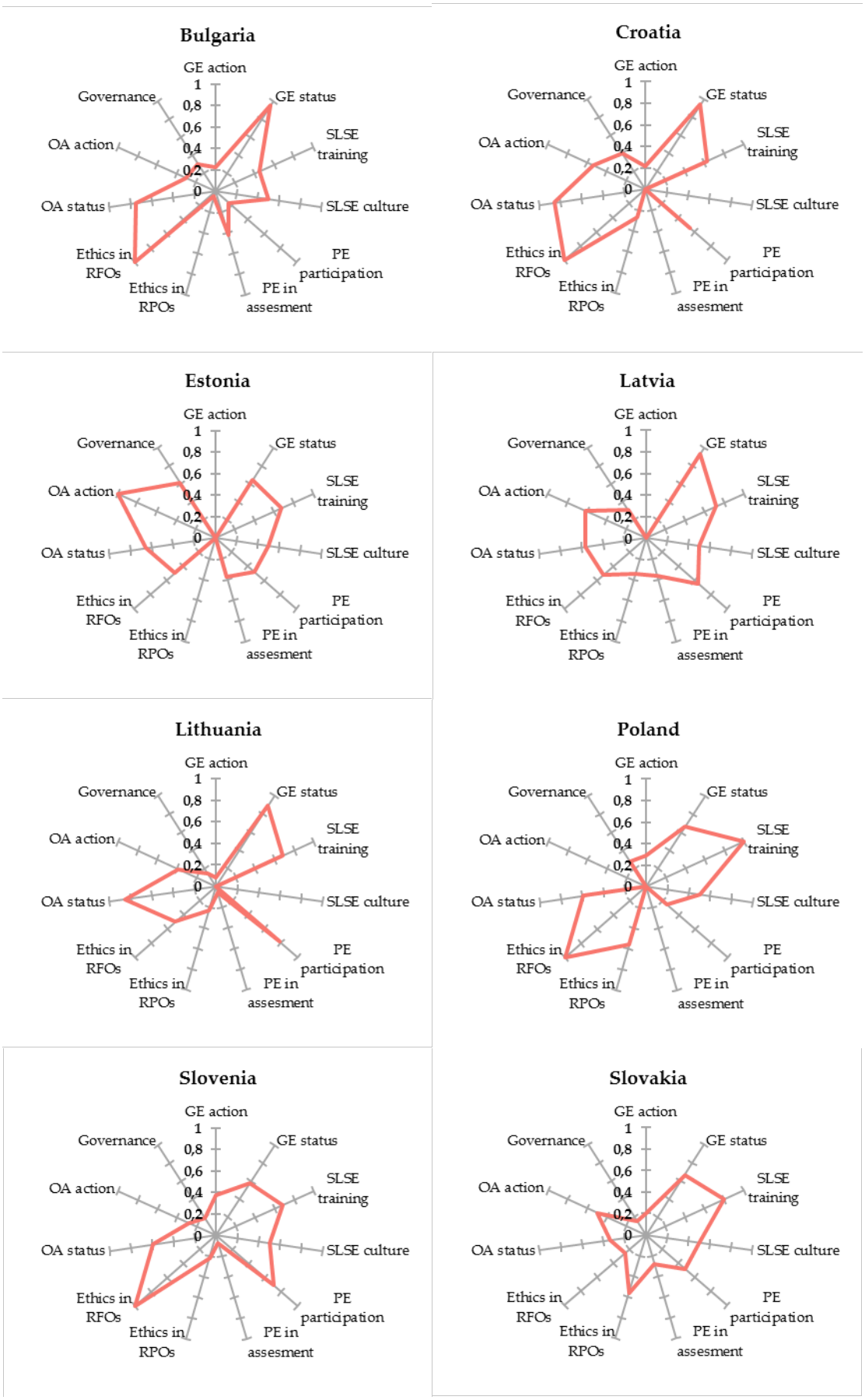




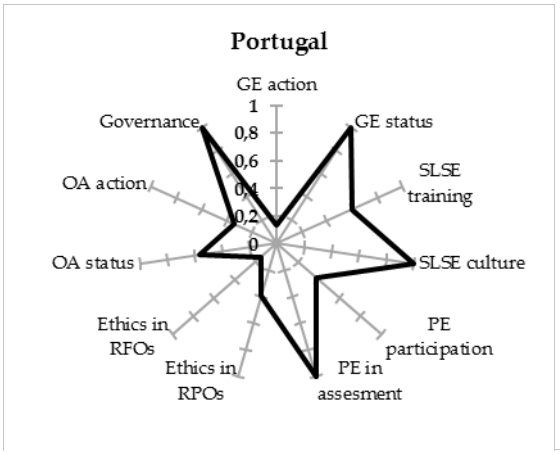


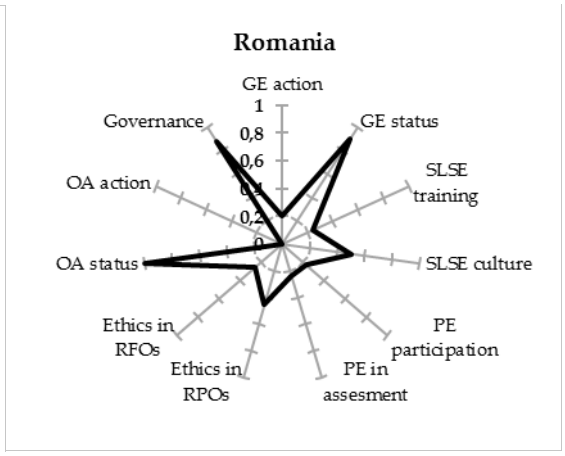


Cluster 2 (red)

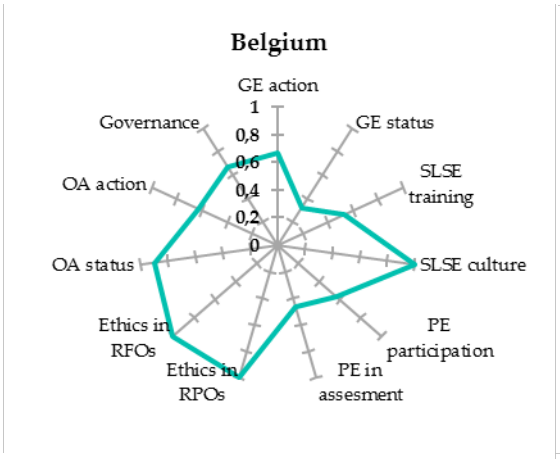


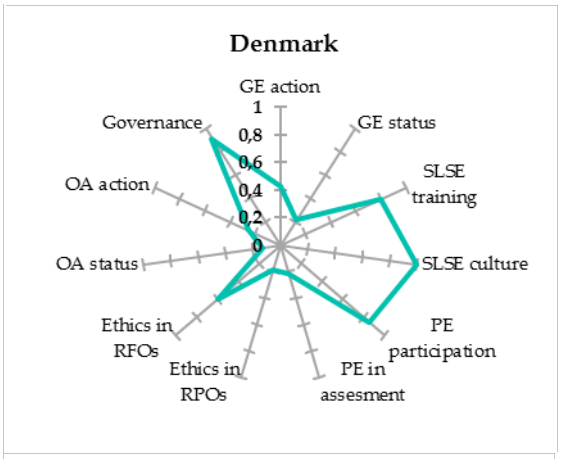
Cluster 3 (black)

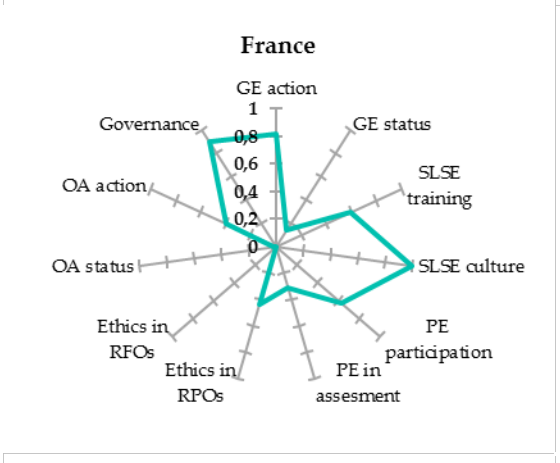


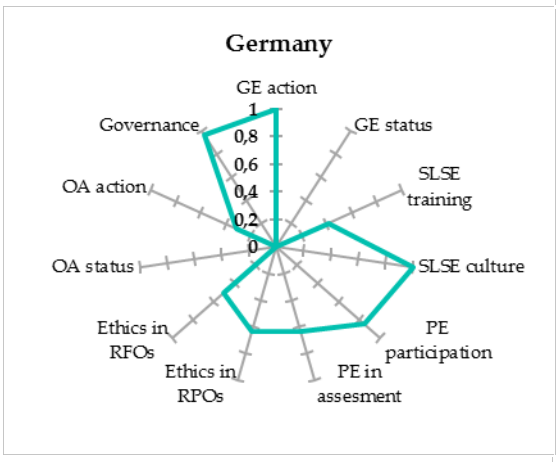


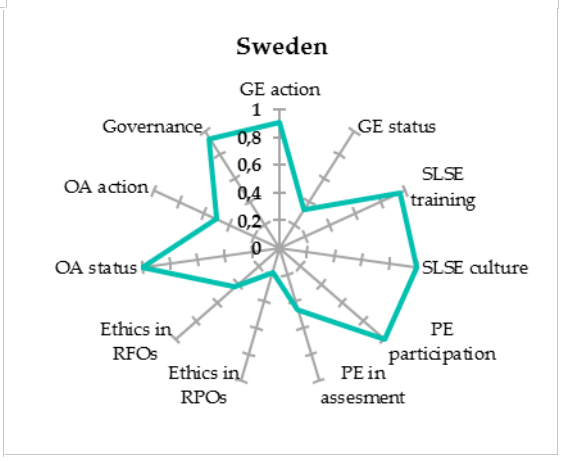
Cluster 4 (green)

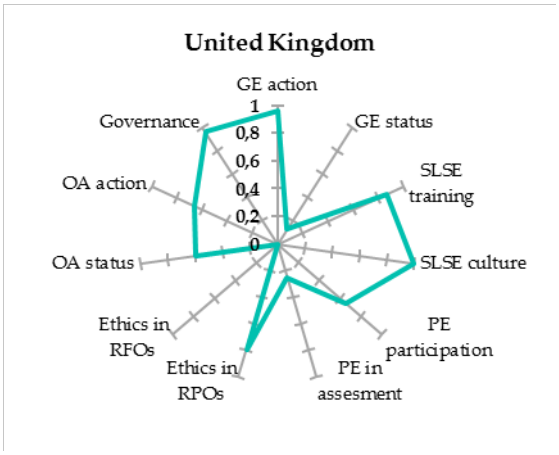











United Kingdom
GE action
1
0,8
0,6
0,4
0,2
0
GE status
SLSE training
SLSE culture
PE participation
PE in assesment
Ethics in RPOs
Ethics in RFOs
OA status
OA action
Governance

ANNEX 2 - LIST OF PUBLICLY AVAILABLE REPORTS

Mejlgaard, N., Ravn, T. (2015): Analytical report on the dimension of citizen engagement and participation of societal actors in research and innovation (D2.1), April 2015

Talmon-Gros, L., Teichler, Th. (2015): Analytical report on the dimension of science literacy and scientific education (D2.2), April 2015

Wroblewski, A., Bührer, S., Leitner, A., Fan, Ch. (2015): Analytical report on the gender equality dimension (D2.3), April 2015

Meijer, I., Potau, X., Tatum, C.C., Costas, R.., Mahieu, B. (2015): Analytical report on the dimension of open access (D2.4), April 2015

Grießler, E., Lang, A., Wuketich, (2015): Analytical report on the dimension of research and innovation ethics (D2.4.1), April 2015

Stilgoe, J., Lindner, R. (2015): Analytical report on the dimension of Research and Innovation Governance (D2.4.2), April 2015

Ravn, T., Nielsen, M., Meilgaard, N., Lindner, R. (2015): Synthesis report on existing indicators across RRI dimensions (D3.1), May 2015

Ravn, T., Nielsen, M., Meilgaard, N. (2015): Metrics and indicators of Responsible Research and Innovation - Progress report (D3.2), September 2015

Kukk, P., Lindner, R., Warnke, Ph. (2016): Update of the literature review & Visioning exercise (D5.1), January 2016

Wuketich, M., Lang, A., Grießler, E. (2016): In-depth case studies on the benefits of RRI across the scientific disciplines and industrial sectors (D5.2), April 2016

Wuketich, M., Lang, A., Grießler, E., Polt. W. (2016): RRI benefits and economic effects: summary and assessment of empirical data (D5.3), December 2016

Woolley, R., Rafols, I. (2016): Development of metrics and indicators for RRI benefits (D6), December 2016

Bührer, S., Lindner, R., Berghäuser, H., Woolley, R., Mejlgaard, N., Wroblewski, A., Meijer, I. (2017): Report on the researchers' survey. (D9.1)

Peter, V., Woolley, R., Spaini, C., Maier, F. (2018): The MoRRI indicators report (D4.3), February 2018

Peter, V., Woolley, R., Spaini, C., Maier, F. (2018): The MoRRI indicators report (Annex) (D4.3), February 2018

MoRRI consortium (2018): Final report

Getting in touch with the EU

IN PERSON
All over the European Union there are hundreds of Europe Direct Information Centres.
You can find the address of the centre nearest you at: http://europa.eu/contact

ON THE PHONE OR BY E-MAIL
Europe Direct is a service that answers your questions about the European Union.
You can contact this service
– by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
– at the following standard number: +32 22999696 or
– by electronic mail via: http://europa.eu/contact

Finding information about the EU

ONLINE
Information about the European Union in all the official languages of the EU is available on the Europa website at: http://europa.eu

EU PUBLICATIONS
You can download or order free and priced EU publications from EU Bookshop at: http://bookshop.europa.eu. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see http://europa.eu/contact)

EU LAW AND RELATED DOCUMENTS
For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex at: http://eur-lex.europa.eu

OPEN DATA FROM THE EU
The EU Open Data Portal (http://data.europa.eu/euodp/en/data) provides access to datasets from the EU. Data can be downloaded and reused for free, both for commercial and non-commercial purposes.

Measuring the Evolution and Benefits of Responsible Research and Innovation (MoRRI) is a project that will come to an end in March 2018. A final public event is foreseen to take place on the 6 and 7 of March 2018, for which this shortened draft final report has been prepared. MoRRI has developed a monitoring system to show the evolution and benefits of RRI across EU member states. It has focused on the EC conception of RRI (namely an operational package consisting of six dimensions: gender equality, science literacy and science education, open access, public engagement, ethics and governance). In and across these dimensions MoRRI has identified a number of monitoring indicators. This has been achieved through desk-based research, participatory workshops, multiple EU-wide surveys, and a series of case studies.

MoRRI's outputs are a significant source of evidence on the benefits of all aspects of RRI for society, the economy and science itself. It demonstrates that RRI does not hinder science and innovation, but actually fosters scientific excellence. In addition to providing evidence of the situation in Europe to date (presenting RRI developments and patterns at country level and identifying country clusters), MoRRI's outputs should help cross-fertilise thinking on the indicators being developed for FP9 (e.g. in terms of baselines, targets, challenges, pitfalls, links to wider MS-level monitoring), and the benefits that can be expected from RRI-related approaches (e.g. such as citizen science and user-led innovation).

Studies and reports


Publications Office